Claims

[c1] A method of fabricating a micro-electromechanical system (MEMS) variable capacitor comprising the steps of:
a) depositing a first dielectric layer on a substrate, said first dielectric layer having at least one cavity etched therein;
b) forming an actuation electrode by filling with metal and then planarizing said at least one cavity;
c) depositing a second dielectric layer on said first dielectric, and etching at least one cavity therein;
d) filling and planarizing said at least one cavity in said second dielectric with sacrificial material;
e) depositing a third dielectric layer on said second dielectric and etching at least one cavity therein;
f)forming a ground plane electrode by filling with metal and then planarizing said cavity in said third dielectric;
g) forming a plurality of metal lines on top of said third dielectric interconnected by way of conductive vias;
h) embedding elastomeric material between said conductive vias; and
i) selectively removing said second and third dielectric material surrounding said metal lines and said ground electrode, and etching away said sacrificial material.

[c2] The method as recited in claim 1, wherein steps g) and h) further comprise the steps of:
forming said conductive vias above said ground electrode in said third dielectric;
etching away dielectric material surrounding said conductive vias;
depositing elastomeric material above said etched vias; and
planarizing said elastomeric material.

[c3] The method as recited in claim 1, wherein steps g) and h) further comprise the steps of:
etching a cavity in a fourth dielectric layer deposited on said third dielectric layer;
depositing elastomeric material in said etched cavitiy; and
forming conductive vias within said elastomeric material.

[c4] The method as recited in claim 1, wherein steps g) and h) further comprise the steps of:
depositing elastomeric material on said third dielectric;
depositing a fourth dielectric layer on said elastomeric material;
etching conductive vias in said fourth dielectric and said elastomeric material;

etching at least one cavity in said fourth dielectric layer exposing said conductive vias; and
filling said at least one cavity with conductive material followed by planarizing said fourth dielectric layer and said conductive material.

[c5] The method as recited in claim 4, wherein step g5) further comprises the step of lining said at least one cavity with barrier material.

[c6] The method as recited in claim 1, wherein said actuation electrodes are separated from said ground electrodes by an air gap.

[c7] The method as recited in claim 1 wherein a voltage applied between said actuation electrodes and said ground electrodes creates an attraction force on said ground electrode and said metal lines, inducing movement of said ground electrode with respect to said actuation electrode.

[c8] The method as recited in claim 1, wherein the conductivity of said elastomeric material changes with vertical displacement, increasing the sidewall area between said ground electrode and said metal lines.

[c9] The method as recited in claim 1, wherein said conductive vias are separated from each other by said de-

formable elastomeric material, said elastomeric material providing mechanical stability and improving reliability.

[c10] The method as recited in claim 1, wherein step d) further comprises the steps of:
d1) depositing an insulating layer above said planarized sacrificial material; and
d2) depositing an insulating layer above said actuation electrodes.

[c11] The method as recited in claim 10, wherein said insulating layers are made of a dielectric material selected from the group consisting of SiN, SiO_2 and SiCN.

[c12] The method as recited in claim 1, wherein said ground plane electrodes and said metal lines are anchored in dielectric material at at least one end thereof.

[c13] The method as recited in claim 10, wherein said dielectric surrounding said electrodes is selected from the group consisting of SiO_2, flourinated SiO_2, and SiCOH.

[c14] The method as recited in claim 1, wherein said ground electrodes and metal lines curl up or down depending on a stress gradient within said metal lines.

[c15] The method as recited in claim 14, wherein said stress gradient in said metal lines comprises the steps of:

a) varying deposition conditions of said metal lines;

b) controlling said deposition conditions and the composition of barrier material surrounding said at least one cavity;

c) varying the thickness of said barrier material; and

d) varying said deposition conditions of said insulating layer above said sacrificial material and said elastomeric material positioned between said conductive vias.

[c16] The method as recited in claim 15, wherein said metal layer is made of a liner material selected from the group consisting of TaN, Ta, TiN, W and copper.